Wood Energy Systems in Commercial and Industrial Settings

Lew McCreery
Wood Innovations Coordinator
USDA Forest Service

MD Clean Energy Webinar Series

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WERC Wood Energy Technical Assistance Team

- Help Facility Owners Evaluate and Implement Wood Energy Projects
- Technology and Vendor Neutral
Modern Wood Energy Systems

Characteristics
- Efficient
- Clean Burning
- Automated

Types
- Firewood
- Pellets
- Wood Chips
  - Semi-dry
  - Green
# Wood Energy Projects

## Driven by Savings

<table>
<thead>
<tr>
<th>Type of Setting</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cord Wood</strong></td>
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<tr>
<td>- Lower fuel costs than pellets</td>
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<tr>
<td>- Low capital costs</td>
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<tr>
<td>- More labor intensive</td>
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<tr>
<td><strong>Wood Chips</strong></td>
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<tr>
<td>- Highest capital cost</td>
<td></td>
</tr>
<tr>
<td>- Lowest fuel costs</td>
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<tr>
<td>- Semi-dry chips = lower capital cost (near pellets)</td>
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<tr>
<td><strong>Pellets</strong></td>
<td></td>
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<tr>
<td>- Highest fuel cost</td>
<td></td>
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<tr>
<td>- Lowest potential capital cost</td>
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## Type of Setting

<table>
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<tr>
<th>Type of Setting</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td><strong>Cord wood</strong></td>
<td></td>
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<tr>
<td>- Small industrial or commercial</td>
<td></td>
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<tr>
<td>- Least automated</td>
<td></td>
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<tr>
<td>- Fuel management is job #1</td>
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<tr>
<td><strong>Pellets</strong></td>
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<tr>
<td>- Smaller commercial or institutional</td>
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<tr>
<td>- Can be completely automated with minimal maintenance</td>
<td></td>
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<tr>
<td>- Minimal fuel storage space</td>
<td></td>
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<tr>
<td><strong>Wood Chip</strong></td>
<td></td>
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<tr>
<td>- Larger institutional, industrial or commercial</td>
<td></td>
</tr>
<tr>
<td>- Larger footprint but semi-dry may = pellet</td>
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</tbody>
</table>
Key Design Points

Goal Maximize Cash Flow

- Type of system
  - Fuel availability and price
  - Level of automation
  - Savings opportunity
- Practical loads to connect
- CHP?
- Sizing the boiler
- Sizing thermal storage
- Fuel flexibility
- Emission Controls
Key project components

300 cy storage

8 mmBtu/hr boiler

175# steam

200 kW turbine/generator

10# steam

Steam to hot water heat exchanger

210°F H2O

6,000 gallons thermal storage

150°F H2O

HX and Distribution Pumps to facility
Thermal Storage Systems

- Energy fly wheel
- Improves combustion
- Reduced boiler size
- Extends boiler life
- Connection to other energy systems - solar thermal
Thermal Storage

Mixing valve

Thermal Storage
Emission Control

- Electrostatic Precipitators
- Fabric Filters
- Multi-cyclones
Flue Gas Condenser

- Improves system efficiency
  - Harves energy from the flue gas
  - Up to 92% system efficiency

- Reduces emissions
  - Targets condensable fraction
  - < 2.5 microns

- Needs low temp load for max benefits
  - 90-100 degree F
  - Pre-heat process water
  - Building heat
Energy Unit Cost for Steam

Green shows MD Tier I REC value, and effective cost of steam is in blue.

- Natural Gas, $7.5/mmBtu: $9.79
- Wood, $27/ton: $3.86 + $1.07 = $4.93 (MD Tier I REC Value)
- Wood FGC, $27/ton: $2.94 + $0.15 = $3.09 (MD Tier I REC Value)

FGC – Flue Gas Condenser
Energy Unit Cost for Cooling

Green shows MD Tier I REC value, and effective cost of cooling is in blue.

- VFD Centrifugal, $141/MWh: $0.052
- Wood Single Effect, $27/ton: $0.042
- Wood Double Effect, $27/ton: $0.031
- Wood FGC Single Effect, $27/ton: $0.044
- Wood FGC Double Effect, $27/ton: $0.024
- Gas Single Effect, $7.83/mmBtu: $0.147
- Gas Double Effect, $7.83/mmBtu: $0.079

FGC – Flue Gas Condenser, VFD – Variable Frequency Drive
Energy Unit Cost for Power

Green shows MD Tier I REC value, and effective cost of thermally-led electric generation is in blue.

- Grid, $0.141/kWh
- BPST Wood, $27/ton: $0.014
- BPST Wood FGC, $27/ton: $0.015
- BPST Natural Gas, $7.83/mmBtu: $0.048

FGC – Flue Gas Condenser, BPST – Backpressure Steam Turbine
GHG Emissions for Steam

NetScope 1 Carbon (GHG) Emissions, kg CO2e/mbtu

- Natural Gas: 66
- Wood: 3
- Wood FGC: 2

FGC – Flue Gas Condenser
GHG Emissions for Cooling

NetScope 1/2 Carbon (GHG) Emissions, kg CO2e/ton-hr

- VFD Centrifugal: 0.093
- Wood Single Effect: 0.043
- Wood Double Effect: 0.023
- Wood FGC Single Effect: 0.032
- Wood FGC Double Effect: 0.017
- Gas Single Effect: 0.996
- Gas Double Effect: 0.535

FGC – Flue Gas Condenser, VFD – Variable Frequency Drive, GHG – Greenhouse Gas
GHG Emissions for Power

Net Scope 1/2 Carbon (GHG) Emissions, kg CO2e/kWh

- Grid: 0.251
- BPST Wood: 0.015
- BPST Wood FGC: 0.013
- BPST Natural Gas: 0.325

FGC – Flue Gas Condenser, BPST – Backpressure Steam Turbine, GHG – Greenhouse Gas
## 2019 Annual Energy Use and Cost

<table>
<thead>
<tr>
<th>Item, Unit</th>
<th>Electric, MWh</th>
<th>Natural Gas, mmBtu</th>
<th>Wood, tons</th>
<th>MD Tier I REC Value</th>
<th>Natural Gas if No Wood, mmBtu</th>
<th>Wood with Flue Gas Condenser, tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>13,015</td>
<td>22,632</td>
<td>13,598</td>
<td>25,904</td>
<td>133,114</td>
<td>9,607</td>
</tr>
<tr>
<td>Cost</td>
<td>$1,838,142</td>
<td>$149,743</td>
<td>$367,141</td>
<td>$246,092</td>
<td>$1,042,314</td>
<td>$259,393</td>
</tr>
<tr>
<td>Unit Cost</td>
<td>$141.23</td>
<td>$6.62</td>
<td>$27.00</td>
<td>$9.50</td>
<td>$7.83</td>
<td>$27.00</td>
</tr>
<tr>
<td>Scope 1 / 2 GHG, mtoe, CO2e</td>
<td>3,267</td>
<td>1,202</td>
<td>271</td>
<td>7,070</td>
<td>191</td>
<td></td>
</tr>
</tbody>
</table>

The value of the MD Tier I Renewable Energy Credit (REC) is identified to show how this impacts economics for this type of facility in MD.

Overall savings on thermal energy is approximately $525,000 vs. historically low natural gas energy charges in 2019. In Maryland, this would be increased to $770,000 with Tier I RECs. Note that the wood system with a flue gas condenser provides the same energy and RECs for over $100,000 less in wood cost per year, or savings increased to $870,000.

This energy is not only significantly less expensive, the net Scope 1 emissions have been reduced by 5,600 metric tonnes per year or 80%. The bulk of the remaining 20% can be avoided by adding another wood boiler to cover more gas use, and this would also increase energy savings.
Summary

- Remember the goal
- Choose the right system
- Properly size the system
- Thermal storage is a key component
- Address emissions controls
- Add flue gas condenser
Wood Energy

- Clean
- Efficient
- Automated
For more information


Lew R. McCreery
Office: 304-285-1538
Cell: 304-288-3655
Lew.McCreery@usda.gov